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SHAREHOLDER WEALTH EFFECTS OF INFORMATION TECHNOLOGY ENABLED SUPPLY CHAIN MANAGEMENT INITIATIVES

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Abstract

In recent years, there has been an increasing interest in using information technology to improve supply chain management (SCM) performance. This study examines the shareholder wealth effects of SCM software initiatives, and thereby contributes to the literature on IT investments and SCM. Specifically, we examined the abnormal stock returns to SCM software initiatives announced by firms between 2000 and 2003. Based on a sample of 346 public announcements, we find that the market returns for SCM software investment announcements were positive and significant. In addition, multiple regression analysis is used to evaluate the impact of several firm specific and investment specific variables on the direction and magnitude of the change in the stock market reactions. We find higher functional scope and higher physical scopes of the SCM projects to be associated with greater abnormal market returns. Our analysis did not indicate firm size or industry affiliation to be significant differentiators of stock market reactions.

Keywords: Supply chain management, information technology, shareholder wealth, event study

Introduction

In recent years, increasing numbers of companies are taking advantage of advanced information technologies and Web technologies to integrate their internal business processes, as well as the interorganizational process spanning their suppliers and customers. The primary goal behind these efforts is to facilitate efficient flow of both goods and information among business partners. Such IT-enabled supply chain initiatives are expected to bring substantial improvements to operational efficiency and cost structure for the companies involved, and lead to sustainable improvements to business performance. The benefits of Web-based supply chain management (SCM) systems are evident in the success of many companies such as Wal-Mart, Dell, and GE. The linkages between effective supply chains and operational performance have also been discussed extensively in both practitioner and academic literature (Aviv 2001; Frohlich and Westbrook 2001; Krause and Scannell 2000; Lee et al. 2000; Ramdas and Spekman 2000; Shin et al. 2000). In addition to the focus on operational improvements resulting from IT-based SCM initiatives, researchers have also started to turn their attention to examining the stock market value impacts of such SCM efforts (Hendricks and Singhal 2003). The primary idea behind this type of study lies in capturing the potential benefits of SCM efforts to shareholders and investors of the company.

Despite the increased academic as well as practitioner interest in understanding the performance impacts of Web-based SCM efforts, little scholarly research has focused on shareholder value impacts of IT-based SCM efforts. Market measures such as stock market returns and Tobin's q have proven to be more reliable measures of a firm's future performance (as compared to traditional accounting-based measures) as they tend to be forward-looking, risk-adjusted, and less susceptible to accounting rule changes (Bharadwaj et al. 1999; Chatterjee et al. 2002; Hitt et al. 2002). Specifically, stock price changes are expected to reflect

the discounted value of all future cash flows of a firm, and represent the collected perceptions of a large group of investors, reflecting more accurate value of the firm. When companies make substantial IT investments, the changes to their stock prices will reflect the investor assessments of these investments, capturing potential improvements in a firm's shareholder value (Chatterjee et al. 2002; Subramani and Walden 2001). The goal of this study, therefore, is to contribute to both the literature on SCM and IT value by empirically measuring the effect of IT-based SCM investments on shareholder value of firms. Specifically, we focus on SCM software investments because that represents the most crucial part of SCM-related IT investment (Buxmann et al. 2004; Lapide and Davis 2003). The specific research questions we address are:

- Do SCM software investments lead to superior market value of firms?
- Do factors such as industry membership, firm size, and the scope of the SCM projects influence the shareholder value generated through SCM software investments?

This study will use event-study methodology to assess the impact of SCM-related software investments on the shareholder value of a firm. Event-study methodology is founded on the efficient markets hypothesis and was first used in the accounting and finance literature to examine the capital market's response to unanticipated information (Brown and Warner 1985; MacKinlay 1997). It was introduced into the management literature (McWilliams and Siegel 1997) and has been employed in previous studies on IT value (Chatterjee et al. 2002; Dos Santos et al. 1993). In this study, an event is defined as a public announcement of SCM software investment made by a company whose stock was traded on one of the major stock exchanges in the United States. We will analyze the abnormal return of a company's stock within a 5-day time period around the event when the firm made an announcement. Abnormal returns are the returns of stocks adjusted for the returns of the overall market.

The rest of this article is organized in the following manner. The next section presents the theoretical foundation and research hypotheses. The research design including data collection is then presented. The methodology for data analysis is described. The article is concluded with a brief discussion of the results.

Literature Review and Development of Hypotheses

There are several streams of research we draw upon in developing the theoretical background and formulating our hypotheses for this study. First, we examined the SCM literature linking supply chain efforts to firm performance using operational and financial metrics. We also reviewed the literature relating information technology to business performance in general and supply chain performance in specific. In addition, various studies focusing on different aspects of business impacts of Web-based technologies and e-business were also examined and incorporated. Based on the literature reviewed, we propose a theoretical framework and research hypotheses linking SCM-oriented software investments to shareholder value creation.

Supply Chain Management, Operational Performance, and Shareholder Value

According to the Supply-Chain Council, supply chain encompasses every effort involved in producing and delivering a final product or service, from the supplier's supplier to the customer's customer. Supply chain management involves coordinating and integrating the flows of materials, information, and services as they move both within a company and among business partners along the supply chain (Cooper et al. 1997; Simchi-Levi et al. 2003). In the past two decades, there has been an explosion of SCM literature with contributions from a variety of fields including operations management, logistics, marketing, strategic management, and management information systems (Chen and Paulraj 2000). A major portion of the SCM research has focused on understanding how different supply chain practices and strategies impact companies' business performance. While some studies employed an analytical modeling approach (Cachon and Fisher 2000; Lee et al. 2000; Taylor 2002), others have investigated the link between SCM and performance empirically using field-based data empirically (Frohlich and Westbrook 2001; Krause et al. 2000; Shin et al. 2000). Most of these studies use metrics such as inventory turnover and lead time reduction, to capture the SCM impact.

Literature on business value of IT has recognized the importance of using financial market-based measures like stock market return and Tobin's q to assess firm performance (Bharadwaj et al. 1999; Chatterjee et al. 2002; Hitt et al. 2002). This stream of research has found significant stock market reactions to IT investment announcements made by corporations. Researchers have found that IT infrastructure announcements, investments in innovative IT applications, and e-commerce-related investments create positive, significant shareholder value for firms.

Although SCM researchers have paid little attention to shareholder value impacts, a recent study by Hendricks and Singhal (2003) proposed a theoretical framework linking a firm's supply chain strategy to its shareholder value. They posited that supply chain strategy of a firm impacts its business performance measured by a set of operational metrics, which determine the efficiency, reliability, and responsiveness of its supply chains. The performance of its supply chain affects both its financial performance and reputation and credibility. These factors in turn affect investors' valuation of the firm. Hendricks and Singhal found stock markets to respond negatively to announcements of supply chain glitches, and the negative reaction is stronger for smaller firms and high growth prospects firms.

In summary, IT research studies empirically show that IT-based investments create significant market value for firms. The study by Hendricks and Singhal informs us that investors take note of SCM glitches and penalize a firm through negative reactions. These studies, as a whole, provide a basis for linking SCM software investments to a firm's market value.

Information Technology and Supply Chain Management

Numerous studies have examined the impacts of IT investments on firm performance (Barua et al. 1995; Brynjolfsson and Hitt 1996; Bharadwaj et al. 1999; Hitt et al. 2002; Santhanam and Hartono 2003; Sircar et al. 2000). In the context of SCM, information technology has long been considered a compelling enabler of supply chain integration and contributor to better supply chain performance. The importance of interorganizational systems and EDI in connecting organizations along the supply chain to create effective supply networks has been studied by many scholars (Christiaanse and Kumar 2000; Kumar and van Dissel 1996; Premkumar 2000). In recent years, Internet-based technologies have emerged as crucial enablers for supply chain integration. As an open standards-based and ubiquitous technology, the Internet allows companies to gain global visibility across their extended network of business partners and the ability to respond swiftly to a changing business environment (Lee and Whang 2001). With the Internet, companies can employ supply chain strategies such as demand chain management that were not possible before (Frohlich and Westbrook 2002). Consequently, there has been a growing body of research that examines the impact of the Internet and e-business technologies on supply chain management (Graham and Hardaker 2000; Johnson and Whang 2002; Tucker and Jones 2000).

Based on their analysis of over 400 journal articles in SCM, Chen and Paulraj (2000) identified a set of key SCM constructs and developed a research framework of supply chain management. They built the research framework based on the view of SCM as encompassing both a firm's internal supply chain and its external links with its suppliers and customers. In this framework, information technology was identified as one of the key constructs that directly impact the key aspects of SCM, including strategic purchasing, buyer-supplier relationships, supply network structure, and logistics integration.

Theoretical Framework and Research Hypotheses

Drawing upon the vast body of literature in IS and SCM, especially Hendricks and Singhal's research framework and Chen and Paulraj's research model, we present our theoretical framework linking information technology in SCM to shareholder value as illustrated in Figure 1. Information technology is first linked to key SCM decision areas such as purchasing and inventory management in acknowledgement of its contribution to these decision areas of SCM (Ballou 1999; Simchi-Levi et al. 2003; Toomey 2000). These IT-enabled supply chain strategies lead to performance gains in the operations of the company. The improvement in operational performance enhances a company's financial performance, which would be recognized by stock market investors and lead to an increase in the stock market's valuation of the company.

With the research framework presented in Figure 1, we can postulate that when a firm announces an SCM software initiative, it represents a significant IT investment supporting one or more decision areas of SCM. The company would gain the potential benefits of improved operational performance from the supply chain strategies supported. The expected gain in operational performance would in turn lead to expected improvements in the company's financial performance. In addition, an SCM software announcement also signals top management's commitment in achieving competitive advantage through improving its supply chain management. Therefore, an investor would view SCM software announcements as an improvement of a firm's future prospect and value the company's stock with a premium over similar firms. This is also consistent with Hendricks and Singhal's finding of a significant negative stock market reaction when companies announce supply chain glitches. Therefore, we propose the following:

H1: The abnormal returns for the stocks of firms announcing SCM software investments will be positive.

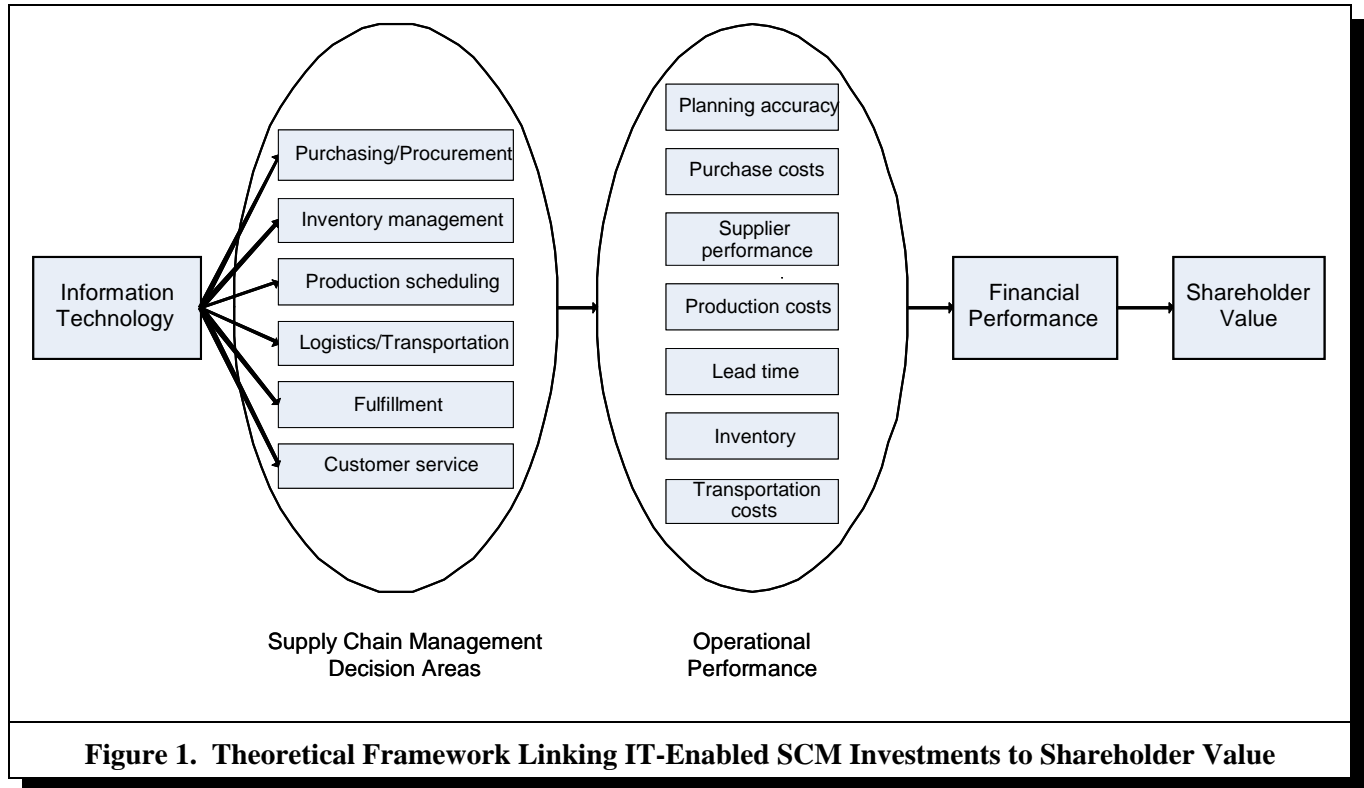


Figure 1. Theoretical Framework Linking IT-Enabled SCM Investments to Shareholder Value

We argue that the stock market would respond positively overall to SCM software announcements in Hypothesis 1. In addition to the overall reaction of the stock market, we are also interested in the factors that moderate the direction and magnitude of the market reaction. Our next two hypotheses concern two of such factors: industry membership and firm size.

Researchers have argued that the importance of SCM varies from industry to industry, based on the extent of information exchange that is required between buyers and suppliers along a supply chain. In more information-intensive industries such as retail or logistics, more information exchange and interaction is required among supply chain partners, therefore, they are likely to derive more benefits from SCM software investments. On the other hand, industries that are less information intensive may not require much information exchange and processing among the supply chain partners. Several studies in the IT literature have empirically identified information intensity as a critical variable determining the strategic importance of IT, as well as the role played by IT in industries. These studies suggest that firms in more information-intensive industries such as retail, logistics, and transportation are likely to get a more favorable reaction from investors when announcing SCM software initiatives because these industries are critically depending on both SCM as well as IT. Therefore,

H2: The abnormal return for the stocks of firms in information-intensive industries (eg: Retail, transportation, logistics) will be greater than those in less information intensive industries.

Firm size has been identified as a critical variable affecting stock market reactions to firm announcements. For example, Freeman (1987) found that the cumulative abnormal returns of small firms exceeded those of large firms for a given level of expected earnings. Collins et al. (1987) argued that firm size is a proxy for the amount of information and for the number of market participants processing the available information about the company, and also found that large and small firms differ in price-earning relations. Hendricks and Singhal found that the stock market's reaction to supply chain glitches will be more negative for smaller firms than larger firms. Large firm tend to possess relatively greater resources as compared to smaller firms, and any SCM software investments might create relatively larger benefits for smaller firms. Event studies examining IT investments have found greater stock market reactions for announcements made by smaller firms as compared to larger ones. Therefore,

H3: The abnormal return for the stocks of smaller firms announcing SCM software investments will be greater than those by larger firms.

In addition to the firm-level variables that moderate the direction and magnitude of the market reaction, we are also interested in the factors affecting each individual investment. Specifically, we are interested in the scope of SCM software investments (Dewan et al. 1998; Ross and Beath 2002). In the context of SCM-related software investments, two forms of scope are of interest: physical scope and functional scope of the investment. *Physical scope* is defined as the range of business units involved in the SCM-related software investment within a firm. While some companies implement SCM software at an enterprise level, others may acquire it only for a specific subsidiary, a manufacturing plant, or a warehouse. Zhu et al. (2004) argue that firms could enhance the value derived from IT investments by implementing IT applications of higher physical scope as these systems would help reduce transaction costs. *Functional scope* concerns the different decision areas of a firm's supply chain involved in the investment. Some companies invested in end-to-end solutions, while others only purchase for a specific area of SCM, for example, e-procurement, inventory management, management of manufacturing plants, or management of distribution. To illustrate with examples, an investment made by Dell to improve the distribution network for the entire enterprise would have a high physical scope and low functional scope. On the contrary, an investment by GE to improve the end-to-end supply chain performance of its aircraft engine business unit would have a low physical scope and high functional scope. As the scope of the SCM-related software investments increases, the expected gain in operational performance would also increase. This in turn leads to an increase in expected improvements in the company's financial performance. Therefore, we propose the following two hypotheses:

H4: The abnormal return for the stocks of firms announcing SCM software investments with higher physical scope will be higher than those with lower physical scope.

H5: The abnormal return for the stocks of firms announcing SCM software investments with higher functional scope will be higher than those with lower functional scope.

Data Collection

We gathered announcements of SCM-oriented software investments from two sources: PR Newswire and Business Wire using the Lexis-Nexis Academic Universe database. Our search covered the time period from 2000 to 2003. Keywords used in the search include *supply chain!* in combination with words like *logistics*!, *procure!*, *warehouse!*, *application*!, *software*!, and *system*!. The full text of articles found was reviewed and those not related to SCM software investments were filtered. After removing duplicate announcements of the same SCM software initiative, we collected 542 events of SCM software investments made by companies traded on NYSE, NASDAQ, or AMEX from 2000 to 2003.

This list was evaluated and refined based on the following criteria: (1) Only those announcements by firms for which sufficient stock price data was available in the CRSP (Center for Research in Security Prices) database were included. (2) Announcements that might be confounded by other key firm announcements such as mergers and acquisitions, profits, dividends, etc., around the announcement period were removed. (3) Multiple announcements in different sources were checked for consistency of the announcement dates. Only those announcements with consistent dates were included. This yielded a total set of 346 announcements for which we had usable returns from the CRSP database. The profile of the companies included in the final data set is presented in Table 1.

Table 1. Profile of Companies in the Data Set					
Industry			Sales (Year of Announcement)		
Industry	Frequency	Percent	Range	Frequency	Percent
Manufacturing	192	55.5	< \$100 million	6	1.7
Retail	94	27.2	\$100 - \$500 million	41	11.8
Transportation	27	7.8	\$500 - \$1 billion	39	11.3
Service	23	6.6	\$1 - \$10 billion	153	44.2
Financial	7	2.0	\$10 billion and above	104	30.1
Other	3	0.9	Data not available	3	0.9
Total	346	100.0	Total	346	100.0

Measures

Firm size was assessed using two measures: logarithm of sales as well as the logarithm of total number of employees. Industries of firms making SCM software announcements were identified based on their SIC codes, and were grouped into five industry types (as shown in Table 1). For physical scope and functional scope of the SCM-related software investments, each announcement in the data set was reviewed and coded manually. We coded physical scope as 0 for those SCM purchases made for a specific business unit, subsidiary, manufacturing plant, or warehouse, and 1 for those investments made at an enterprise level or covering entire organization. Similarly, functional scope was coded as 0 for those made for only one specific subarea of SCM, for example, procurement, inventory management, or distribution, and 1 for those investments made in multiple areas, including those made for end-to-end supply chain solutions.

Data Analysis and Results

The market model that estimates the rate of return on stock price of firm i on day t is expressed by the following equation:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where R_{it} is the rate of return on share price of firm i on day t ; R_{mt} is the rate of return on market portfolio of stocks (CRSP index) on day t ; α refers to the intercept term; β_i is the systematic risk of stock i , and ε_{it} refers to the error term. The abnormal returns of firms are estimated using the ordinary least squares regression model, represented as follows:

$$AR_{it} = R_{it} - (a_i - b_i R_{mt})$$

a_i and b_i represent the OLS parameter estimates obtaining by regressing R_{it} over R_{mt} over an estimation period prior to the event, and AR_{it} refers to abnormal returns of firm i on day t . The cumulative abnormal returns ($CAR_{t1,t2}$) are calculated by averaging the daily abnormal returns over a time period (event window) between $t1$ and $t2$, for a sample of N firms using the following equation:

$$CAR_{t1,t2} = \left\{ \sum_{j=1}^N \sum_{j=t1}^{t2} AR_{it} \right\} / N$$

The date of SCM announcement was considered as day 0. The trading days prior to the announcement day were numbered as $t = -1$, $t = -2$, and so on, and subsequent trading days were numbered as $t = +1$, $t = +2$, and so on. We calculated cumulative abnormal returns (CAR) over a two day time period (0, +1) as suggested by Dos Santos et al. (1993) and Im et al. (2001). In order to see the sustainability of the changes, we also examine the CARs over three (-1, +1) and five (-2, +2) day event periods surrounding the event date. We used an estimation period of 200 days that ended 45 days before the event date. Findings from our analysis are provided in Table 2.

Table 2. Cumulative Abnormal Returns for SCM Software Investment Announcements				
Event Window	Abnormal Returns for SCM Software Investment Announcements			
	Mean CAR (%) with Z – Statistics		Rank test - No. of positive : negative CARs with Z – Statistics	
(0, +1)	0.70	2.892**	185:161	2.430**
(-1, 0)	0.50	1.678*	185:161	1.507 ^{\$}
(-1, +1)	0.82	2.391**	184:162	2.189*
(-2, +2)	0.97	1.671*	180:166	0.912

^{\$}Significant at $p < .1$; *significant at $p < .05$; **significant at $p < .01$.

As can be seen from Table 2, firms announcing SCM software investments gained an average abnormal return of 0.70 percent in the (0, +1) window, and 0.82 percent in the 3-day window (−1, +1) surrounding the event date. To add robustness to our results, we also performed nonparametric rank tests that compared the number of firms with positive CARs with those with negative CARs (Table 2). These results further strengthened our earlier findings. Clearly, the number of firms with positive abnormal returns significantly outnumbered those with negative returns. These findings provide support to our hypothesis H1.

To test our second and third hypotheses, we ran the following regression model:

$$CAR_i = b_0 + b_1I_{1i} + \dots + b_5I_{5i} + b_6S_i + b_7P_i + b_8F_i + e_i$$

where CAR_i is the cumulative abnormal return for event i , b_0 is the intercept of the regression, I_{1i} to I_{5i} are the dummy variables for industry types, S_i represents the firm size, P_i and F_i are the physical and functional scopes, with e_i representing the random error term. The correlations among the variables are presented in Table 3, and the regression results are provided in Table 4.

Table 3. Correlation Among Variables

Variables	1	2	3	4	5	6	7	8	9
CAR(0,+1)	1								
Industry – Finance (2)	.020	1							
Industry – Manufacturing (3)	.066	−.154**	1						
Industry – Retail (4)	−.092**	−.082*	−.695**	1					
Industry – Service (5)	−.021	−.037	−.309**	−.166**	1				
Industry – Transportation (6)	.039	−.039	−.330**	−.177**	−.079*	1			
LN(Sales) – Firm size (7)	−.055	−.003	.078*	−.033	−.127**	.032	1		
Physical Scope (8)	.101**	.084*	−.147**	.098**	.064	.007	−.128**	1	
Functional Scope (9)	.211**	−.034	.053	.007	−.091**	−.007	−.040	.080*	1

**Significant at $p < .05$; *significant at $p < .1$

Table 4. Regression Results

Independent Variables	β	t		R^2	Adjusted R^2	F	
		Value	Sig.			Value	Sig.
(Constant)		.571	.568	.065	.045	3.236	.002
Industry – Finance	.010	.189	.850				
Industry – Retail	−.103	1.846	.066				
Industry – Service	−.029	−.528	.598				
Industry – Transportation	.021	.385	.701				
LN(Sales) – Firm size	−.043	−.787	.432				
Physical Scope	.091	1.655	.099				
Functional Scope	.200	3.704	.000				

[Note: The model was also tested using number of employees as an alternate measure of firm size. The results were similar.]

Our regression analysis yielded some interesting findings. Our overall model was significant with adjusted R^2 of 4 percent. Our low R^2 value is not unusual, as several event studies in both IS and accounting/finance literature have reported similar values (Chatterjee et al. 2002). As can be seen from Table 4, only one industry variable, retail, emerged significant. This provides only partial support to our hypothesis H2, which predicted firms in information-intensive firms will enjoy greater abnormal returns following SCM software investment announcements.

Our results provide no support for effects of firm size. Our regression results provide strong support for scope-effects of SCM software investments. Both functional scope and physical scope were found to be significantly associated with cumulative abnormal returns. Therefore, our fourth and fifth hypotheses were supported.

Discussion and Conclusions

In summary, we examined the stock market reactions to SCM software investment announcements during a 4-year period (2000 through 2003) using an event study methodology. The results indicated that the stock market rewarded firms announcing SCM software investments during the time period. The stocks of these firms achieved 0.97 percent average abnormal return during the 5-day event window around the announcements. Our findings contribute to the IT investment literature and SCM literature by providing empirical evidence for linking SCM software investments to a firm's stock market valuation. Our findings did not indicate firm size or industry affiliation to be differentiators of stock market reaction to SCM software investment announcements. We also found higher functional and physical scopes of SCM software investments to be associated with greater abnormal returns.

We believe our study makes some important contributions to research. First, it provides strong support for investor reactions to SCM software investments. Our study clearly shows that capital markets suitably reward those firms undertaking SCM software investments. Second, our results point to scope effects in IT implementation. SCM software implementations with high functional and physical scopes resulted in more positive returns, implying that investors perceive higher scope of IT implementation to significantly contribute to future performance of the firm. SCM projects with restricted scope might address some existing bottlenecks in the supply chain, but the complete potential of supply chain integration is possible only when a firm undertakes a complete end-to-end SCM project. Third, some of earlier event studies on IT investments have produced mixed results regarding market value impacts of IT (Dos Santos et al. 1993; Im et al. 2001). It is possible that these studies combined all kinds of IT investments, and such aggregation resulted in insignificant findings. Our study joins those studies that have examined specific categories of IT investments such as IT infrastructure and IT application investments (Chatterjee et al. 2002), e-commerce investments (Subramani and Walden 2001), and ERP investments (Ranganathan and Samarah 2001), and further validates that *focused IT investments* attract investor attention and reaction. Our study also has some important messages for IT and SCM executives. The main message that our study brings out is that firms planning to undertake technology-based SCM projects could enhance their shareholder value by doing so. It is also important that these executives undertake SCM-projects with greater scope so that potential gains from such projects could be fully realized.

Like any other study using an event-study methodology, our results should be viewed with the limitation of using market-based measures for assessing firm value. Stock market valuation only reflects investors' collective perception of firms' potential business gains from an initiative, which need not exactly reflect the actual, realized gains. Our low R^2 value (despite being significant) also points to several additional factors that might affect the investor reactions to SCM event. Factors such as supply chain intensity, current state of automation in supply chain, and firm-specific factors such as overall supply chain infrastructure could play a critical role in determining the success of SCM software investments. Further, the supply chain software market consists of several vendors ranging from large software houses to small- and mid-sized software firms. Perceptions regarding the vendor and the capabilities of their software could also influence investor reactions. Examining such additional factors might be a fruitful research endeavor in the future.

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